FAMILY LARSSON ROSENQUIST FOUNDATION

dedicated to human milk

About the Foundation

The Family Larsson-Rosenquist Foundation is one of the first foundations in the world with a prime focus on promoting and supporting breast milk and breastfeeding. Based in Zug, Switzerland, it was founded in 2013 with the aim of promoting the scientific and public recognition of breastfeeding and breast milk as – given the current state of science – the best nutrition for newborns and infants. It considers itself as an instigator and promoter of new knowledge. The Foundation invests globally in projects and scientific research in breastfeeding and breast milk. It places high value on multidisciplinary collaboration and supports projects with a sustainable impact on the well-being of mother and child.

Breastfeeding and Breast Milk – from Biochemistry to Impact

A Multidisciplinary Introduction

Published by
Family Larsson-Rosenquist Foundation

Book Preview

Thieme

An Evidence-Based Reference Book: a Key Resource for Decision Makers and Practitioners

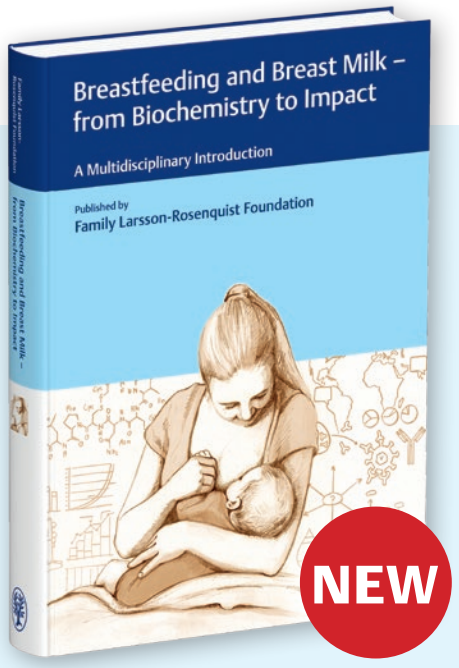
Authors from around the globe, each a specialist within their field have readily contributed to provide readers with a comprehensive overview of breastfeeding and human milk to encourage and empower interested parties to move breastfeeding higher up on the public health agenda.

There are many books available looking at “how to” breastfeed or focusing on a single topic within the field, others look at the biomedical aspects of milk, however none address a wide range of research disciplines to provide a truly multidisciplinary comprehensive overview: covering topics from physiology and psychology, culture, politics and economics to HIV and medications, NICU and human milk banking. The topics are varied, yet all relevant and important elements in the quest to increasing breastfeeding rates.

Multidisciplinary Introduction to Breast-feeding and Breast Milk – from Biochemistry to Impact is written for a wide and varied audience, ranging from nursing staff and lactation experts who have daily contact with mothers and babies, to health ministers who want to learn about how scaling up of breastfeeding can contribute to reducing their health care expenditure. It is also a key for doctors and researchers who have an interest in the topic yet are not fully aware of all the benefits that breastfed infants enjoy. Based on sound science but written in popular science style, ensuring an easy read, the book provides a comprehensive and solid foundation including sources and references. It also features a unique in-depth scientific glossary of lactation that provides definitions for a plethora of important terms of breastfeeding and human milk that are science based and reviewed by acknowledged experts in the field.

The book aims to provide a holistic overview, and is divided into four parts with individual introductions. As each chapter covers a topic in depth, it can be also be read independently. Furthermore, the book can be used as a Dip-In-and-Out book as each chapter provides a summary of the topics covered at the beginning as well as a list of key findings and messages at the end of the chapter. This allows the reader to quickly identify topics and peruse key findings to identify areas of specific interest and to read the book in a more targeted manner.

Overall this book provides a unique insight into a wide range of aspects of breastfeeding, humanmilk and lactation, empowering individuals with the knowledge to increase public interest and towork towards the goal of making breastfeeding the norm again.



Available at the end of September 2018

Also available as an e-book

Breastfeeding and Breast Milk – from Biochemistry to Impact
A Multidisciplinary Introduction
Published by Family Larsson-Rosenquist Foundation
Georg Thieme Verlag, Stuttgart, 2018

Edition: 1
Pages: 416
Illustrations: 73
ISBN 978-3-13-220401-0 (Print)
eISBN 978-3-13-220421-8 (e-book)
eISBN 978-3-13-220411-9 (PDF)

For further information please visit Thieme Webshop:
www.thieme.de/shop/p/000000000311610101

or the Family Larsson-Rosenquist Foundation:
www.larsson-rosenquist.org/en/projects/ReferenceBook.html

FAMILY LARSSON ROSENQUIST FOUNDATION
dedicated to human milk

Thieme

Contents

Part 3
Human Milk in Special Circumstances

Part 4
The Way Forward

Part 5
Addendum

2 Breast Milk, Global Health and Sustainable Development

Leith Greenslade, MPP, MBA

Expected Key Learning Outcomes

- Why breastfeeding is so important
- How breastfeeding can help reduce the inequalities in health
- The health and economic benefits from increasing breastfeeding rates
- Reasons why mothers do not breastfeed despite all the evidence from research demonstrating the benefits
- The required change of policy focus needed to support a global increase in breastfeeding rates

2.1 The Importance of Empowered Mothers

Nature has empowered mothers with control over the production and distribution of an extraordinarily protective substance for the health and development of their babies — breast milk. This evolutionary innovation provides all of the nutrition an infant needs for the first six months of life and affords protection from infectious diseases, reduces the risk of sickness and death, and contributes to healthy digestive and brain development well into early childhood.

Unlike the vast majority of health interventions, breast milk is wholly owned and operated by mothers who function as "doctors" administering their "medicine". To unleash the protective powers of breast milk, mothers must not only be knowledgeable about the benefits of breast milk. They must also be freely able to exercise their choice to breastfeed, unfettered by external barriers. If mothers cannot breastfeed due to sickness or absence, they should be able to ensure that their babies have access to their own breast milk and, where that is not possible, to donor breast milk from the newborn period onwards.

It is critical that development actors confront the reality that for almost all mothers — an estimated 140 million women give birth every year — breastfeeding is not always a choice. Depending on the severity of the barriers, a mother may be so constrained by forces beyond her control (e.g., lack of education, lack of family support, the need to earn an income) that she cannot exercise a preference to breastfeed. For many tens of millions of mothers, breastfeeding is not possible in the environments in which they live. For these women, reducing or removing the external constraints is what will ultimately lead to sustained increases in breastfeeding.

Women facing the most significant barriers to breastfeeding are also most likely to live in communities where the costs of not breastfeeding fall most heavily on children. These are the populations where very low breastfeeding rates coexist with very high rates of newborn and child sickness and death. Empowering mothers in these high-risk environments to exercise a real choice to breastfeed in supportive homes, workplaces, and public spaces should be the primary focus of development efforts to increase breastfeeding rates.

2.2 The Benefits of Breast Milk

In the past 15 years the health benefits of breastfeeding have become extremely well known and extensively promoted. There is consensus among the global health community that breast milk confers its powerful protective properties on children by providing all of the nutrients, vitamins, and minerals children need in the first six months of life, alongside antibodies that combat infectious diseases, especially diarrhoea and pneumonia [1], [2], and enzymes for optimal digestion. There is now widespread acceptance that the health benefits of breastfeeding continue well into early childhood, and potentially beyond. The benefits of breastfeeding for women include reduced risk of pregnancy and potentially lower lifetime risks of certain cancers, obesity, diabetes, and heart disease [3].

Several *Lancet* series on maternal, newborn, and child health and nutrition have laid out the evidence for the benefits of breast milk. The Maternal and Child Undernutrition Series [4], the Maternal and Child Nutrition Series [5], the Childhood Pneumonia and Diarrhoea Series [6], the Every Newborn Series [7], and the Breastfeeding Series [8] all cite evidence that breastfed babies are much more likely to survive the first six months of life [9], that initiation of breastfeeding within 24 hours of birth could reduce the risk of newborn death by 43% of all newborn deaths [10], [11], [12] and that breastfeeding could prevent 823,000 child deaths and 20,000 breast cancer deaths annually [13]. Other sources accord with these findings, including the Born Too Soon Report, which stresses the importance of breast milk for preterm babies [14], and the Global Burden of Disease Study 2016, which ranks "suboptimal breastfeeding" as a leading behavioural risk factor in child death, especially across African and Asian countries [15]. According to this body of evidence, no other single intervention has the power to prevent newborn and child deaths at the scale of breast milk.

There is less consensus about the long-term health and related benefits of breastfeeding for both breastfeeding mothers and breastfed infants. The many studies that report adult health benefits including reductions in heart disease, diabetes, and cancers; cognitive improvements including higher IQ; and even economic gains including higher educational performance and income [16] all suffer from methodological weaknesses as they are based on cross-sectional retrospective studies rather than randomised control trials. A recent meta-analysis of these studies cautioned that these methodological challenges limit the ability to draw firm conclusions [17], [18].

The 2016 *Lancet* Breastfeeding Series quantified the impact of these health and development benefits on healthcare costs and economic growth, reporting that increases in breastfeeding rates could save US$400 million in healthcare costs in the US, UK, Brazil, and China alone, and inject US$300 billion into economies from more productive workforces [19].

2.3 Breastfeeding as an Equity Strategy

Children born to low income families in high-risk environments disproportionately benefit from the special protective properties of breast milk because they are more likely to be exposed to infections exacerbated by poor living conditions and less likely to access quality healthcare as formal health services so often fail to reach them. A recent study reported that a 10% increase in breastfeeding prevalence across all households resulted in a larger absolute reduction in child deaths in the poorest households [20]. The authors concluded that breastfeeding is better positioned to reduce wealth-related child health inequalities than other interventions.

Although breastfeeding is one of the few health interventions where the gaps in coverage between high and low income households are narrow in low income countries, early and exclusive breastfeeding rates among poor families remain very low [21]. Globally, just 40% of infants from the poorest households are exclusively breastfeed for the first six months of life, and in many countries with the highest child mortality breastfeeding rates are even lower [22]. For example, the ten countries with the highest child mortality rates all have exclusive breastfeeding rates below 50% (▶ **Table 1.1**), and several have rates below 20%. Further, eight of the ten countries with the largest numbers of child deaths have exclusive breastfeeding rates below 50% (▶ **Table 1.2**). These include India, Nigeria, Pakistan, China, Democratic Republic of Congo, Indonesia, Angola, and the Philippines.

Despite recent improvements in breastfeeding rates in some countries, the rate of progress overall has been slow over the last 25 years [23].

▶ **Tab. 1.1** Breastfeeding rates in countries with the highest child mortality rates, 2015.

Country	Child Mortality Rate 2016	% Early Breastfeeding (0–1 hour) 2008–2015	% Exclusive Breastfeeding (0–6 months) 2008–2015
Angola	157	55	No data
Somalia	133	26	5
Chad	127	29	3
Central African Republic	124	44	34
Sierra Leone	114	54	32
Mali	111	46	34
Nigeria	104	33	17
Benin	98	50	41
Democratic Republic of Congo	94	52	48
Cote d'Ivoire	92	53	23
Niger	91	53	23
Global Average	41	43	40

Source: World Bank and UNICEF, latest.

▶ **Tab. 1.2** Breastfeeding rates in countries with the highest newborn and child deaths, 2015.

Country	Number Newborn Deaths (0–1 month, 2015)	Number Child Deaths (0–5 years, 2015)	% Early Breastfeeding (0–1 hour)	% Exclusive Breastfeeding (0–6 months)
India	696,000	1,201,000	41	62
Nigeria	240,000	750,000	33	17
Pakistan	245,000	432,000	18	38
China	93,000	182,000	41	28
Democratic Republic of Congo	94,000	305,000	52	48
Indonesia	74,000	147,000	49	42
Angola	53,000	169,000	55	No data
Sudan	39,000	89,000	73	55
Kenya	34,000	74,000	58	61
Philippines	30,000	66,000	50	27

Source: UNICEF, 2015 and World Bank, latest.

Among the 33 countries with the slowest rates of reduction in child mortality, only four have exclusive breastfeeding rates above 50% – Burundi, Togo, Papua New Guinea, and Lesotho [24]. This lack of improvement in breastfeeding rates in countries struggling to prevent child deaths implies that there are considerable equity gains to be made in targeting their most vulnerable populations for breastfeeding improvements, particularly in the countries with very low vaccination rates [25]. To leverage the equity impact of breastfeeding in full both within and between countries, it is critical that the global development community prioritises breastfeeding support in the populations with the lowest absolute rates of breastfeeding and breastfeeding progress, the weakest health infrastructure, and the highest burdens of newborn and child death.

2.4 The Cost-Effectiveness of Breastfeeding

Like many prevention efforts, breastfeeding investments are highly cost-effective. The 2013 Lancet Maternal and Child Nutrition Series reports that breastfeeding promotion compares very favourably with other nutrition intervention packages and has the power to reduce hundreds of thousands of child deaths at an annual cost per life saved of $US175. Of ten single nutrition interventions assessed by The Lancet, only the management of severe acute malnutrition and preventive zinc supplementation saved more lives than breastfeeding promotion, and of four intervention packages modelled, only the management of acute malnutrition saved more lives at lower cost than breastfeeding promotion [26].

Further, the 2014 Lancet Newborn Series reported that the earlier breastfeeding support services reach mothers after birth, the greater the impact on newborn health and breastfeeding duration. The Series cited that education and counselling can improve exclusive breastfeeding rates by 43% the day after birth and by up to 30% in the first month after birth. Kangaroo mother care, a strategy that improves the health of babies born too small, also encourages breastfeeding, with studies showing a 27% increase in breastfeeding rates at one to four months after birth and an increased breastfeeding duration. This body of research estimates that where a specific population can achieve 90% coverage of breastfeeding promotion exclusive breastfeeding rates can increase by 15% in newborns and by 20% in children aged one to five months [27].

Yet despite the evidence of the cost-effectiveness of breastfeeding support programmes, international development spending on breastfeeding programmes has never been high. Indeed, it has been declining since the 1990s and is now at historically low levels relative to other health prevention areas, most notably vaccines and insecticide-treated bed nets [28]. The relatively high level of investment in vaccines and in malaria prevention is one of the reasons why they are responsible for preventing such a large proportion of child deaths since 1990 in so many countries [29]. The fact that breastfeeding contributed so little to the 50% reduction in child deaths achieved over the life of the Millennium Development Goals begs a critical question: Could we have actually achieved the 66% reduction in child deaths required to achieve Goal 4 with greater investments in breastfeeding promotion and support?

2.5 Breastfeeding's Poor Performance

Despite the significant health and equity benefits of breastfeeding, and the cost-effectiveness of breastfeeding support services, rates of breastfeeding in most countries fall below the World Health Organization's (WHO) recommendations (early initiation of breastfeeding within one hour of birth, exclusive breastfeeding until 6 months of age, and continued breastfeeding until 2 years of age or older), and the World Health Assembly's target of at least 50% exclusive breastfeeding [14]. Globally, just 40% of babies are breastfed exclusively for the first 6 months and 43% in the first hour after birth, far below the coverage rates achieved by other child survival interventions such as vaccines (86%), Vitamin A (72%), and skilled birth attendance (78%). Currently, only 32 countries have achieved the 50% exclusive breastfeeding target and many countries struggling with high burdens of newborn and child mortality have rates far below 50%.

Progress in closing the high breastfeeding coverage gaps has also lagged other areas of global health. According to the Countdown to 2015 Final

5 Why Breastfeeding?

Berthold Koletzko, Univ-Prof. Prof. h.c. Dr. med. habil. Dr. h.c.

Expected Key Learning Outcomes

- **The importance of optimum nutrition in the first months after birth**
- **The effect of early nutrition on later life**
- **The importance of good health and nutrition for mothers during pregnancy and throughout lactation**

5.1 Introduction

There is no other period of time in human life when the quantity and quality of nutritional supply are of greater importance than during the first months after birth. This is due to the extremely rapid growth of infants who normally double their birth weight in 4–5 months and triple it in the first year; such a growth rate demands a very high requirement of energy and nutrients per kilogram of body weight [1], [2]. The capacity to compensate for a diet that is insufficient in quantity or inadequate in nutritional value is limited. Body reserves of nutrients are very restricted and, particularly during the first months of life, some body functions are not fully developed, such as nutrient absorption, metabolism, and renal conservation. In addition to this fast rate of body mass gain there is a rapid development and differentiation of tissues and organs. During this period of developmental plasticity, environmental cues such as nutrition and metabolism have modifying effects on growth, development, and long-term function and health. An increasing body of evidence indicates that nutrition, particularly during the first two years of life, has a marked impact on later physiology, health, and disease risks; this is commonly referred to as the 'metabolic programming of lifelong health and disease' or the 'developmental origins of adult health' [1], [3], [4].

5.2 The Evolution of Lactation

Breastfeeding is the natural form of infant feeding and is universally recommended [5]. The composition of human milk is believed to have developed during a very long evolutionary process to match the needs of both lactating women and their infants optimally. Lactation and milk feeding in mammalian species is believed to have evolved over a period of about 250–300 million years, and to have originated from synapsid animals that provided fluid from cutaneous glands to protect their parchment-shelled eggs from desiccation [6], [7]. These ancestral cutaneous glands are thought to have evolved by combining features of skin glands into new functional entities. Gland secretions were then provided with antimicrobial properties to protect eggs and hatchlings from infection, and organic components to supplement offspring nutrition [8]. The immune properties of milk from various mammalian species show wide variation in anti-inflammatory and immunomodulating agents, including immunoglobulins, iron-binding proteins, lysozyme, oligosaccharides, and leukocytes. This variability appears to compensate for differences in developmental delays in early postnatal production of antimicrobial factors among species [9], [10]. Moreover, the composition and concentrations of different immunological agents in mammalian milks relate to differences in placental type and function, lactation pattern, and environments and also follow different evolutionary strategies.

Similarly, the evolutionary development of highly nutritious milks has led to diverse variation in mammary gland anatomy, milk output, length of lactation, and nutrient content (▶ **Table 5.1**, ▶ **Table 5.2**), and in the relative contribution of milk feeding to the offspring's total nutrient supply during their initial growth period. For example, the wide inter-species variation in milk protein content, a key driver of offspring growth, is closely related to offspring growth velocity (▶ **Fig. 5.1**). The relatively low protein concentration in human milk is an adaptation to the lower needs of human infants who have slower weight gain rates compared to, for example, calves or kittens. Moreover, the protein supply in human milk falls substantially with increasing duration of lactation. The protein intake per kilogram body weight of a breastfed infant at 6 months represents only about 55% of the intake after birth (▶ **Fig. 5.2**). Underlining evolutionary adaptation of lactation to the needs of the species, this change is in accordance with the decrease in protein requirement with increasing postnatal age, which is a consequence of a slowing of infant growth rate.

Recent genome studies provide support for the hypothesis that during the evolution of lactation, the maternal energy cost of breastfeeding has been limited while aiming to maximise offspring survival. In effect, this would have promoted survival of the maternal-offspring pair and therefore survival of the species. The genome analysis of

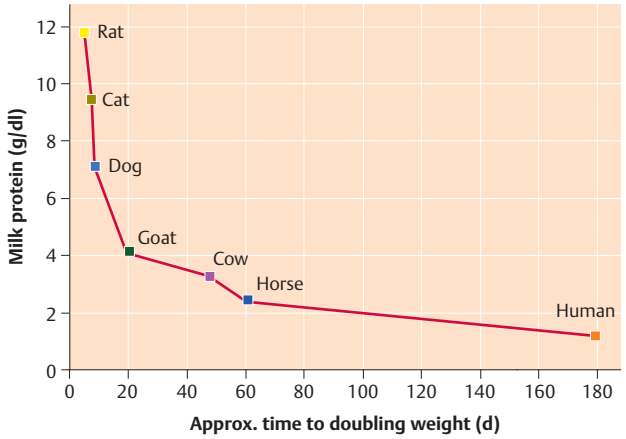
▶ **Tab. 5.1** Selected anti-infectious and anti-inflammatory components in human milk.

Cellular components	Humoral and other components	
Neutrophil, granulocyte, macrophages	Immunoglobulins (sIgA, IgG, IgM, IgD)	Haptocorrin
Lymphocytes	Complement and complement receptors	Osteopontin
Mammary gland epithelial cell membranes	Toll-like receptors	Fibronectin
Milk fat globoli membranes	Soluble CD14	Lactoperoxidase
	β-Defensin-1	Human milk oligo- and polysaccharides and glycoconjugates
	Cytokines, e.g. IL-10, TGFβ	Monoglycerides and non-esterified fatty acids
	TNFα and IL-6 receptors	Complex lipids
	IL-1 receptor antagonist	Nucleotides
	κ-Casein, α-lactalbumin	Mucins
	Lysozyme	Lactadherin
	Lactoferrin, lactoferricin B and H	

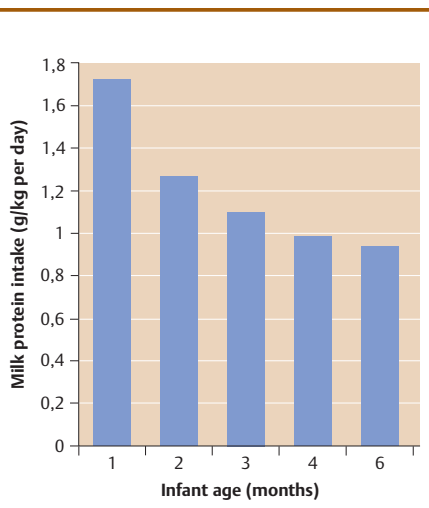
Modified from [57].

▶ **Tab. 5.2** Milk composition (% weight) among nine species.

	Water	Protein	Fat	Lactose	Ash
Human	87.7	1.8	3.6	6.8	0.1
Cow	86.6	3.4	4.6	4.9	0.7
Buffalo	84.2	3.9	6.6	5.2	0.8
Sheep	79.4	3.5	8.6	4.3	1.0
Pig	89.6	1.3	4.8	3.4	0.9
Dog	75.4	11.2	9.6	3.1	0.7
Rat	68.3	11.3	14.8	2.9	1.5
Whale	70.1	9.5	19.6	1.8	1.0
Seal	32.3	11.2	34.8	2.6	0.9



▶ **Fig. 5.1** Protein content of mammalian milks relative to time to doubling of offspring weight. Note the low human protein milk content in humans matching relatively slow offspring growth.



▶ **Fig. 5.2** Decrease in milk protein intake in a breastfed human infant in the first six months reflecting the decrease in infant growth rate. Milk protein intake is calculated as 75% of crude protein intake.

seven mammalian species (human, cow, dog, mouse, rat, opossum, and platypus) indicates a high degree of conservation of milk genes and mammary genes. Such conservation seems to have evolved more slowly than for other genes, even in cows selectively bred for effective milk production [7]. The most variable parts of the lactome were those with nutritional or immunological characteristics. This leads to speculation that evolutionary selection (specifically of these genes) occurred in response to different environmental and nutritional needs and to infectious challenges. Interestingly, most conserved genes are those for proteins of the milk fat globule membrane, suggesting they may have a central biological role.

In spite of its high metabolic cost, the evolution of lactation has been accompanied by the global biological success of mammalian species. This supports the hypothesis that there are major benefits to lactation due to the nutritional and antimicrobial properties of milk and the associated extended period of mother-infant contact. The regular and frequent transfer of milk, particularly in humans and other non-human primates, provides offspring with close interaction with their mother and therefore more learning opportunities, which may have facilitated the development of high levels of intelligence found in humans and other primates.

While we have yet to learn much about the evolutionary process of lactation over the last 250–300 million years and the biological consequences for humans today, the available evidence indicates that human breastfeeding has evolved to be highly adapted to the needs of both mothers and infants. A tempting question is whether new areas of vulnerability might arise from the discordance between the slow evolutionary adaption of the human genome affecting biological characteristics such as breastfeeding and human milk composition and the rapid environmental and human lifestyle changes particularly within the last century. These questions warrant investigation in future studies.

5.3 Assessing Health Effects of Breastfeeding

There is considerable data supporting the health effects and benefits of breastfeeding for mother and infant, and these have been evaluated in systematic reviews [10], [11], [12], [13], [14], [15]. Given that breastfeeding is widely considered as the natural and optimal mode of infant feeding, it is generally thought unethical to randomise infants to either breastfeeding or breast milk substitutes. As such, the evidence is almost entirely based on epidemiological data from observational studies. A limitation to this is that the decision to breastfeed and the duration and exclusivity of breastfeeding are associated with a variety of factors that predict health outcomes, e.g., socioeconomic status, education, and lifestyle factors including smoking habits, physical activity, dietary choices, and use of preventive healthcare. Thus, there is a high risk that the effects and effect sizes of breastfeeding are overestimated if there is no adjustment for such confounding factors. Even with adequate adjustment, there remains the risk of residual confounding, partly because not all confounders can be quantitatively assessed. A review and analysis by Ip and co-workers details the methodological issues and considerable differences in the quality of studies assessing breastfeeding effects. This report rated study quality with regard to study methodology when evaluating the evidence, a practice not often considered by other authors. Ip, et al. concluded that prospective longitudinal cohort studies provide a better opportunity for adequate assessment of confounding variables than retrospective or cross-sectional studies [14].

The author of this article is aware of only one randomised controlled trial performed at the end of the 20th century. In this trial conducted in four antenatal clinics in Nairobi, Kenya, women infected with human immunodeficiency virus type 1 (HIV-1) infection were randomly assigned to either breastfeeding (n=185) or formula feeding (n=186) their infants to assess potential effects on vertical HIV transmission [16], [17]. Mortality rates adjusted for HIV-1 infection status, morbidity, and nutritional status were monitored during the first two years of life. Today, enhanced knowledge of strategies to mitigate the risk of HIV transmission during breastfeeding and particularly effective antiretroviral therapy has changed the approaches to breastfeeding in HIV-positive women in low income countries. Therefore, such a randomised trial in HIV-positive women would no longer be feasible today.

However, it has been considered ethical to cluster-randomise hospitals to standard or enhanced breastfeeding promotion. With the aim to evaluate the effects of breastfeeding promotion in hospitals on breastfeeding success, such a cluster-randomised trial (the PROBIT trial) was performed in 31 hospitals in Belarus [18]. The PROBIT trial compared an experimental intervention modelled on the World Health Organization and United Nations Children's Fund Baby-Friendly Hospital Initiative with a control intervention. The experimental intervention emphasised health care worker assistance with initiating and maintaining breastfeeding, and lactation and postnatal breastfeeding support [18]. Although not primarily designed for such a purpose, the study followed children to later ages to evaluate the health effects of varying breastfeeding duration [19], [20]. Studies have also randomised breastfed infants to earlier or later introduction of complementary feeding, and hence to different durations of exclusive or predominant breastfeeding [21], [22], and to earlier or later introduction of specific complementary feeds [23], [24], [25]. These rare randomised trials are extremely valuable, but their conclusions are limited to the questions originally addressed. The discussion on the health effects of breastfeeding presented here is based primarily on observational studies, with the caveat that the reported effects and effect sizes are likely to be confounded by oth-

11 Human Milk in Economics Context

Subhash Pokhrel, PhD, MSc

Expected Key Learning Outcomes

- The economic considerations for mothers
- The impact of breastfeeding on health systems
- Analysis of how far breastfeeding promotion and support interventions offer good value for money
- Effective ways to invest in breastfeeding promotion
- Outline of a business case made for breastfeeding promotion and support in the absence of robust economic evaluation

Human milk has several implications. Depending on what perspective one chooses, the use of alternatives to human milk for feeding infants has attracted enormous debate in the past. This chapter surveys contemporary literature around the economic value of breastfeeding and presents an example analysis to show how a business case for breastfeeding support could be made.

11.1 Economics of Lactation

What economic value may human milk have? This question has featured in both academic and political debates for a long time. For some, human milk is protective against certain disease conditions and therefore it can provide substantial economic benefits. Breastfeeding is beneficial not only to the health and wellbeing of a child and their mother, but it also generates substantial cost savings to the national health services. Health services would have to treat fewer infant, childhood, and maternal diseases with increasing breastfeeding prevalence [1], [2]. In addition, some authors argue that women who choose to breastfeed actually produce and supply breast milk and therefore contribute significantly to the national economy [3], [4]. When costs of implementing breastfeeding support policies are considered, society is more likely to get a positive return on investment (ROI) from breastfeeding [2].

The other side of the argument positions breastfeeding as a costly enterprise to women because, if they chose to breastfeed their babies, they would be required to incur substantial private costs to enable milk expression [5]. Like formula feeding, breastfeeding is also associated with private costs. In addition, breastfeeding may have implications for earnings and productivity of working women, potentially requiring a longer maternity leave, working part time, or missing opportunities for promotion [6], [7], [8]. It also takes a substantial amount of a mother's time to breastfeed her child [9]. Therefore, both the private costs and the forgone opportunities women may experience by choosing to breastfeed can be considerable.

Underneath these individual benefit-cost arguments rests a question that has probably the most profound implications for any breastfeeding support policy. Can a health system ask women to initiate breastfeeding, and breastfeed for longer and exclusively, particularly when we, as a society, recognise that it is up to women themselves to make those explicit choices? What determines a woman's decision to initiate (or cease) breastfeeding and how those factors relate to the thinking of a healthcare system appear to be central to this question [10]. Therefore, it is important to consider whether breastfeeding is in fact an "economic" decision for women as well as for other stakeholders.

11.1.1 Breastfeeding as an Economic Decision

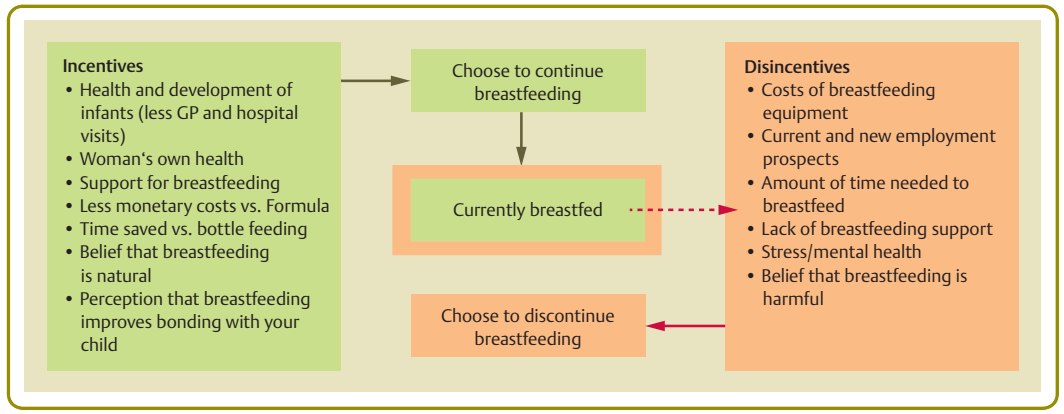
Breastfeeding is an economic decision but its nature varies according to the perspective taken. Working women may consider the consequences of breastfeeding (i.e. opportunities foregone and/or monetary costs of breastfeeding relative to formula feeding) when deciding whether to breastfeed their babies, while employers and health systems may consider the need to support breastfeeding women through maternity pay and by creating baby-friendly workplaces and hospitals [11].

Maternal employment appears to be negatively associated with breastfeeding initiation and duration [12]. This is particularly relevant since exclusively milk-feeding mothers would have to spend much more time every week on feeding their baby compared with other mothers [9]. Understanding incentives or disincentives facing women that may influence their choices regarding initiation and duration of breastfeeding (any or exclusive) is therefore critically important.

Economic theories help us to understand what those incentives and disincentives might be, and how these may determine a women's choice to breastfeed or formula feed and for how long. One such theory is that of individual net-benefit (utility) maximisation; in this case, individuals are assumed to make a choice (e.g., to initiate breastfeeding) that is perceived to benefit them and adhere to their decision until the benefits outweigh the costs [10]. In this framework, any factor that is perceived as a barrier or disincentive by a mother, e.g., money, time, and negative feedback from friends or family, is a cost. Likewise, any factor that is perceived as a facilitator or incentive, e.g., money saved by not buying formula, better health of the child, bonding with their child, and access to breastfeeding support, is a benefit. The model also assumes that the incentives and disincentives to breastfeeding may change over time.

▶ Fig. 11.1 depicts this notion of the decision making process proposed by Racine and colleagues [10]. In this construct, the decision is an economic choice; the postpartum women weigh the benefits of breastfeeding against the costs of continuing or discontinuing breastfeeding. Some factors that are incentives for health systems (e.g., the health benefits of breastfeeding for infants/children and for mothers) are also incentives for women. Although provision of breastfeeding support requires health systems to cover costs, this support is also an incentive for women encouraging them to choose to breastfeed.

Racine and colleagues implemented this model in a sample of 1,595 low-income families in the US, and found that the decision to discontinue breastfeeding was significantly associated with a number of disincentives: the Supplemental Nutrition Program for Infants, Women, and Children (WIC) participation at 2–4 months, mothers returning to work for 20–40h per week, mothers not attending a postpartum doctor's visit, fathers not being in the home, a smoker in the household, no receipt of breastfeeding instruction at the paediatric office, the doctors not encouraging breastfeeding, and the mother experiencing depressive symptoms [10]. The main implication of this finding is that any breastfeeding promotion programme will need to address disincentives associated with breastfeeding cessation. Understanding the economics of breastfeeding decisions is therefore helpful for policymakers.



▶ **Fig. 11.1** A schematic representation of the Net-Benefit (utility) Maximisation model of breastfeeding decision proposed by Racine et al. (Reproduced from [10])

Although the Net-Benefit (utility) Maximisation model is a valuable way to identify determinants of breastfeeding decisions that women may take (i.e. initiate, continue or discontinue; any or exclusive breastfeeding), the decision itself is complex. The decision not to breastfeed infants is also the decision to formula feed (i.e. use infant food or breast-milk substitutes). Infant food is often allocated by markets. If we were to rely on markets to allocate resources efficiently, consumers (i.e. postpartum women) would have to make informed (rational) choices. These choices require that postpartum women themselves are responsible for the full costs and benefits of their infant food purchase decisions. Much cultural knowledge of health risks of formula feeding is based on inaccurate or biased information and this, coupled with commercial vested interests, may not enable women to make an informed (rational) decision [13]. It is known that not choosing to breastfeed leads to a decrement in infant and maternal health, thereby costing health systems millions of dollars [1], [14]. Those health systems costs are usually borne by taxpayers (as in the British National Health Service [NHS]) or others (e.g., social/private insurance) and not by women who make consumption decisions (purchase of breast-milk substitutes), a phenomenon known as externalities (an attribute of market failure). This is particularly important as the extent to which the women who choose to use breast-milk substitutes are willing to bear this cost is less understood. In this instance, the market price of artificial infant food becomes much lower than its true economic costs to women who want to purchase it, making breastfeeding a less attractive option [13].

Another linked issue around the use of markets to allocate infant food efficiently is that of agency. In the case of infant feeding, one could argue that the infants are the actual consumers and not their mothers. Mothers make decisions on behalf of their infants – a classic principal-agent problem in economics [15]. While agents (mothers) make decisions on behalf of their principals (infants), it is likely that agents are acting in their best interests rather than in the best interests of their principals. It is argued elsewhere that given the difficulty to accommodate the needs of the breastfeeding mother in the context of institutional frameworks, it is likely that the interests of the mother and the infant may not always align [13].

Whether to breastfeed is thus a complex decision that postpartum women have to make by weighing the incentives (benefits) and disincentives (costs) of breastfeeding relative to that of formula feeding. Breastfeeding is not a binary choice; it is rather a set of complex choices around initiation, duration, and exclusivity. What women decide to do on infant feeding may have far reaching implications beyond their families.

11.1.2 Private Costs of Breastfeeding and Formula Feeding

One of the economic disincentives (costs) associated with women's infant feeding decisions is private costs [10]. Despite breast milk being considered as the best form of nourishment for infants and usually in sufficient supply for the first few months of life, it is not free for women who choose to breastfeed. There are private costs associated with breastfeeding. Two types of private costs are prevalent: monetary costs and time costs.

In a study conducted in Liverpool, England 149 women between the age of 18 and 43 were asked to report the purchases associated with their infant feeding practices (mean age of infants: 13 weeks) [5]. The study identified a number of equipment items needed to enable women to breastfeed. This included nursing bras, nightshirts, breast pads, antiseptic nipple spray, breast cream, breast shells, nipple shields, breast pump, breast-milk storage bottles, breast-milk freezer bags, steriliser, and support pillow. Two separate models (high costs and low costs) were used to estimate the average costs of purchasing the equipment. A set of breastfeeding equipment was purchased for £34.60 per week (high-cost model) or £2.40 per week (low-cost model). Likewise, formula feeding mothers had bought bottles, teats, steam steriliser, formula, bottle warmer, bottle carrier, powder dispenser and bottle/teat brushes. A set of formula-feeding equipment including the food was purchased for £31.43 per week (high-cost model) or £6.30 per week (low-cost model).

On average, breastfeeding cost women £11.58 per week compared with £9.60 per week for formula-feeding (2002–2003 prices). However, the study found that women, particularly the first-time mothers, in both groups, 'spent money on items that were not needed or used only once or twice' [5]. Higher spending was characterised by education, socio-economic status and age. Although women included in the study spent more per week on breastfeeding compared with formula feeding, provision of better support (information) could have led the women to avoid purchasing items that were unnecessary or to go for cheaper alternatives where available.

Depending on the healthcare context, there may be other forms of private monetary costs associated with infant feeding. Frick and colleagues identified food for the mother herself and medical care use for herself or her child (in non-NHS/insurance settings) as potential private costs required to enable mothers to breastfeed [16].

The choice of infant feeding is also associated with time costs. In particular, 'exclusive breastfeeding is time intensive, which is economically costly to women' [9]. In an Australian survey (2005–2006), 139 new mothers were asked to report their average weekly time spent on feeding (milk or solids), feeds preparation, and the total of the two. Mothers who were exclusively breastfeeding spent on average 7 hours extra per week on milk feeding their infants compared with other mothers. This difference was statistically significant and implied that premature weaning was probable 'for women who are time-stressed, lack household help from family, or cannot afford paid help' [9].

The time costs of breastfeeding have wider implications. As exclusive breastfeeding is associated with substantial time commitment, working women in particular may have to compromise on their earnings and productivity as choosing to breastfeed means choosing to take longer maternity leave or work part time and potentially miss promotion opportunities [6], [7], [8]. For others, the time spent on breastfeeding could have other usage [10]. The opportunities forgone by choosing to breastfeed may therefore be considerable. Breastfeeding promotion policies must therefore subsidise/share these costs through provision of various services, e.g., childcare, help with housework, prolonged maternity leave, and if mothers decide to return to work, the provision of breastfeeding breaks at the workplace [13].

11.1.3 Supporting Women who Choose to Breastfeed

As seen above, breastfeeding is an economic choice that women make. Therefore, it is important to support women to breastfeed for as long as they choose to. It appears that most women who stop breastfeeding don't want to and often consider getting the help and support that would keep them breastfeeding for longer and exclusively [17]. Supporting women who choose to breastfeed would therefore help align interests of the mother, the baby, and the health services. As breastfeeding (exclusive and/or longer duration) becomes more common as the result of this support, this will lead to wider economic benefits too [2], [14].

Central to any policy debate around breastfeeding should be the recognition that to breastfeed is an exclusive choice of a new mother. Any breastfeeding support policy therefore must acknowledge that new mothers who have chosen to breastfeed are well informed, well trained and well supported for however long they choose to breastfeed (exclusively or partially). It is possible that a breastfeeding promotion policy may help new mothers initiate breastfeeding; support thereafter enabling women to breastfeed for longer is what generates health and economic benefits to the mother, the baby, and the health services.

11.2 Economics of Breastfeeding Support

Having established the notion that supporting women who choose to breastfeed makes an economic sense, it is important to look at the evidence base to see what health benefits breastfeeding may offer to mothers and their babies. How would the positive health effects of breastfeeding translate into economic benefits both to national health systems and to wider society? At the micro level, do breastfeeding support interventions offer good value for money?